# High Energy Line Break (HELB) Limit of CUF = 0.1

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# High Energy Line Break Issue (1/2)

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- High energy line break (HELB) Class 1 piping locations in some plants are limited to a cumulative usage factor of 0.1
  - Mainly (only?) BWRs
  - Documented in FSARs
- For license renewal to 60 years, this basis had to be maintained
  - Several plants had difficulty meeting CUF < 0.1 for HELB locations for 60 years
  - Hatch plant in 2000-2002 time frame
- HELB was also an identified issue for new plants
- The NRC intended to investigate this criterion in as part of their EAF research started in 2010 under a joint User Need Request #1 sponsored by NRR and NRO

# High Energy Line Break Issue (2/2)

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- The NRC held an EAF public meeting on January 5, 2012 and discussed HELB
  - Meeting summary and all presentations available at ML120120028
  - Structural Integrity/EPRI presented work on an Improved Basis and Requirements for Break Location Postulation (EPRI Technical Report 1022873, October 2011, publicly available); that work performed leak probability probabilistic calculations are argued for a revised criterion = 1.0
  - The NRC also explained their rationale behind the HELB criteria

- Subsequently, the industry identified that they had no identified need for HELB issues to be addressed until the 2020s

- Based on the above, the NRC delayed the HELB work from Under Need Request #1
  - It was felt that the Extremely Low Probability of rupture (xLPR) code, when completed, could address this issue
  - At that time (~2012), the xLPR code was forecast for completion in 2018, so it would be available for use commensurate with the industry's need

- Subsequently, in 2014, NRO escalated their need to address the HELB issue; this led to a second User Need Request

# High Energy Line Break User Need #2

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- Issued jointly by NRR and NRO in January 2015
- Related to Standard Review Plan 3.6.2 on pipe rupture postulation
- Cumulative usage factor criterion for postulation of pipe rupture: CUF ≥ 0.1
  - A conservative criterion that may not have a well-understood basis
  - Determine/document the basis behind the criterion
  - Develop options for revising the criterion
- Jet force modeling
  - Evaluate water jet force models (ANSI/ANS 58.2 and NUREG/CR-2913) against laboratory data and computational fluid dynamics calculations
  - Make recommendations for regulatory positions

# General Design Criterion 4

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- "…components important to safety shall be designed to accommodate the effects of…postulated accidents."
- Missile generation, flooding, pipe whip, increased temperature and humidity, and water jet impingement
- Possible outcome: installation of pipe whip restraints or jet impingement shields
- SRP 3.6.2 describes methods acceptable to the staff for complying with GDC 4
- SRP 3.6.2 references the jet force models and Branch Technical Position 3-4

# History of BTP 3-4

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| Title | Revision | Date |
|---|---|---|
| MEB 3-1 | 0 | September 1975 |
| MEB 3-1 | 1 | July 1981 |
| MEB 3-1 | 2 | June 1987 |
| BTP 3-4 | 2 | March 2007 |
| BTP 3-4 | 3 | July 2016 |

- BTP 3-4 provides methods acceptable to the staff for determining postulated break locations
- Many criteria are stress based
- B.1.(ii)(1)(b) for Class 1 and B.1.(iii)(1)(c) for Class 2 have a cumulative usage factor criterion, CUF≥0.1
- Conservative criterion but the technical basis is not well documented

# CUF Criterion

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- Begins with the 1972 Giambusso letter (found in Appendix B of BTP 3-3, ML070800027)
- Early versions state that the fatigue criterion is only considered when the maximum stress range exceeds a certain value, but that caveat was removed in later versions
- January 2012 public meeting on fatigue issues (ML120120028)
  - EPRI presented a risk-informed approach to postulated break locations (Report 1022873)
  - Staff determined conservatism in the 0.1 criterion may be warranted due to environmental fatigue affects
  - If environmental effects were accounted for, staff demonstrated willingness to accept 0.4 as a criterion
  - The staff was not aware of a compelling reason to update the criterion at that time

# ESBWR Design Certification

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- Economic Simplified Boiling Water Reactor (ESBWR)
- Adopted 0.4 as CUF criterion when environmental effects were accounted for
  - Basis for this decision is not clearly documented, but it has roots in a 1986 memo (Legacy Library 8603060209B)
- The staff updated BTP 3-4 in July 2016 to include
  - "For new reactor design certification reviews, the staff has considered a CUF limit of 0.4 to be acceptable when the effects of EAF are considered in the piping design."

# Other References

- American Nuclear Society Standard 58.2
  - Very similar to BTP 3-4
  - Adopts CUF ≥ 0.4
  - ANS was not able to provide the technical basis for this criterion
- 1986 Memo with Rodabaugh letter attached
  - Derives CUF ≥ 0.4 approach
- S. R. Gosselin and F. A. Simonen, "A Risk-Informed Approach to Fatigue Break Criterion for ASME Class 1 High Energy Piping," Proceedings of the 20th International Conference on Nuclear Engineering, July 30 – August 3, 2012, Anaheim, CA, ICONE20-54534.
  - A risk-informed approach to the CUF criterion
- EPRI 1022873, "Improved Basis and Requirements for Break Location Postulation," EPRI, Palo Alto, CA, October 2011.

# Current Status of User Need #2

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- CUF criterion
  - Background information gathered and organized
  - Draft TLR written but not finalized
  - All NRC work on the CUF criterion has ceased due to low priority

- Jet force models
  - RES recently restarted research on jet force calculations
  - The focus is to provide conservative modeling guidance for HELB jet force calculations
  - Potential work includes updating ANSI/ANS 58.2-1988 standard
  - Work performed in RES/DSA, POC: Jason Thompson

# What's Next?

- The HELB issue is expected to arise again for Subsequent License Renewal (SLR); the previous industry need still exists
- A few questions to ponder:
  - *Do any PWRs use CUF = 0.1? Why not?*
  - *Why do some BWRs have CUF = 0.1 and others do not?*
  - *How did B31.1 plants address this issue (since these plants do not have CUFs)?*
- Discussion - What's next?